Management of reconfigurable multi-standards ASIP-based receiver

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***Abstract* — The emergence of multiple wireless standards is introducing the need of flexible platforms which are able to self-adapt to various environments depending on the application requirements. Our work lies in the domain of self-adaptive heterogeneous multiprocessor architectures. In this paper, we present our ideas about the management of an ASIP-based multi-standards iterative receiver, which includes the support for turbo-decoding. In this context, the management of a multi-standards receiver provides the services for the self-adaptation mechanisms based on a collect and an analysis of information, a decision making process and a fast reconfiguration of the platform.**

***Index Terms* — Self-adaptation, ASIP, Wireless multi-standards receiver.**

I. Introduction

LAST years have seen the multiplication of standards for wireless communications used in embedded systems. As example, a mobile phone has to deal with wireless standards such as: GSM, 3GPP2 and 3GPP-LTE for phoning functions, Wi-Fi (802.11) and WiMax (802.16) for wireless local and wide area networks. These wireless standards propose different adjustable parameters to provide best performance under a particular environment. In this context, the flexibility of telecommunication platforms is a key point. They have to be able to process several standards, to manage the switching between these standards, and the adaptation of standard and architecture parameters depending on the observed environment, the application requirements and the platform capabilities.

To protect the information during wireless transmission, the convolutional turbo codes [1] provide a good way to reach high throughput and low error rate. Turbo codes are obviously good candidates for multi-standards receivers.

We choose to use an ASIP-based architecture. This choice is motivated by the fact that the configuration process, which consists of memories loading, is faster, and less complex than hardware reconfiguration. This approach is a compromise between Homogeneous Multi Processor and Full Custom platforms. A flexible ASIP-based receiver has been previously developed at LabSTICC [2] [3] to reach a high degree of flexibility and performance. This platform performs turbo-equalization, turbo-demodulation and turbo-decoding for Wi-Fi, WiMax, 3GPP-LTE and the DVBs standards.

In this paper, we present our first ideas to add configuration decision to such architectures, namely for the management of reconfigurable multi-standards ASIP-based receivers for wireless communication. The paper is organized as follows. Section II presents the multi-ASIP receiver used in our work. Section III describes three realistic scenarios in the context of embedded wireless multi-standards receiver. Section IV describes the platform dynamic reconfiguration problematic while section V concludes the paper.

II. Multi-ASIP Platform

The generic architecture of the multi-ASIP based architecture is shown in Fig.1. Three ASIPs have been developed to perform the main functions of this architecture. The first is called EquASIP [3]. It performs channel turbo equalization to mitigate the detrimental effects of Inter Symbol Interference. This architecture can be used for multiple MIMO space time codes and provides support for Alamouti Code, Golden Code and spatially multiplexed MIMO-OFDM environment. The second, called DemASIP [3], is dedicated to the demapping function. This ASIP can be used for multiple modulation schemes adopted at the transmitter side. The DemASIP provides support for BPSK to 256-QAM constellation for any mapping style with or without Signal Space Diversity. Finally, the TurbASIP [2] performs the decoding function. It supports convolutional turbo codes up to eight-state double binary turbo codes or sixteen-state simple binary codes.

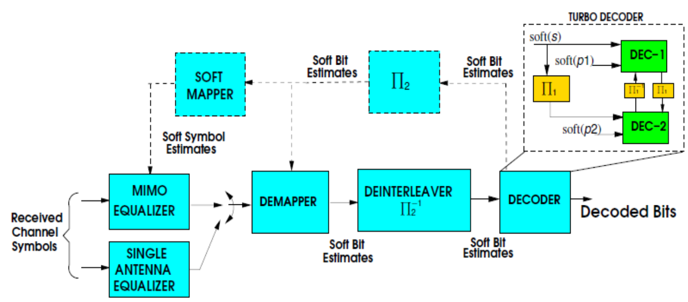

Fig.1. Generic architecture of a unified turbo receiver.

All ASIPs provide intern levels of parallelism and several ASIP of the same type can be used simultaneously to reach high throughput. The flexibility of the ASIPs and the degree of parallelism provides a large choice of possible configurations. Consequently, the platform needs a manager, which is able to dynamically: observe the environment, analyze the collected information, choose a judicious configuration and finally configure the platform with respect of QoS requirements and objectives that may be fixed by, the user and the application. In this case, requirements are assessed data and objectives are defined as function to minimize or maximize featuring power consumption for instance. It is important to note that requirements, objectives and the environment can evolve dynamically to create new scenarios of execution.

III. Realistic scenarios

In the context of wireless communications, we choose to use three metrics to define three types of realistic scenarios for wireless multi-standard receiver. The first metric represents the quality of the communication channel and is called Signal-to-noise ratio (SNR). The second metric is the required throughput for a given application and the third metric is the required Bit Error Rate (BER) for the same application. From these metrics we defined three realistic scenarios which represent three use cases of a wireless multi-standard receiver.

A. One application executed in a dynamic environment

In this scenario, the user is moving and launches a unique application that requires wireless communication. An example of this scenario could be a person who is watching TV on his mobile phone during a train trip.

The required throughput and the BER depend on the application so they are fixed while SNR depends on the environment so it is variable. The manager has to be able to tune parameters such as modulation type, code rate, number of iterations and level of parallelism to adapt the platform in order to keep the throughput and the BER in a range of acceptable values for the application.

B. Several applications executed in a static environment

In this scenario, the user doesn't move and launches different applications which require wireless communication. An example could be a person who waits in a station and first watch TV, then call a friend and finally use a web browser to find out about news.

Required throughput and BER change for each application while the SNR is fixed. The manager has to be able to tune parameters to adapt the platform for the application requirements.

C. Several applications executed in dynamic environment

This scenario, shown in Fig.2, is a mix of the two previous ones. The user is moving and launches different applications which require wireless communication.

The three metrics evolve dynamically. The manager has to adapt the platform for the application requirements in a dynamic environment.

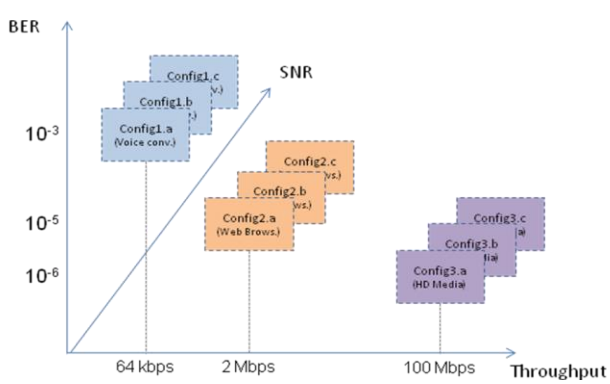

Fig.2. Dynamic launching of application in a dynamic environment.

Carrying out of these scenarios require the dynamic reconfiguration of the receiver depending on the applications requirements, the environment and the platform capabilities. The next section presents the challenge for ASIP-based receiver reconfiguration.

IV. Reconfiguration problematic

In the context of wireless communication it is important to carry out this reconfiguration efficiently to avoid the lost of information. To anticipate the evolution of future application requirements we propose to design a manager which is able to reconfigure the platform in few microseconds. For that purpose, it is necessary to define a management policy, in order to observe and analyze the collected information, make some decisions to adapt the platform at run time, and finally design an architecture which allows loading of few hundred of bytes in different memories banks with respect to the reconfiguration time constraint. The reconfiguration concerns the definition and the management of the number of each ASIP too. Depending of the configuration, the number of each ASIP can differ so it necessary to implement an ASIP management to turn on/off the different ASIPs.

The manager handles the dynamic reconfiguration of the multi-standard platform. Each ASIP of the platform can be reconfigured by loading new program and new parameters in several memories. To load a new configuration, three and two memories have to be considered for the TurbASIP and the DemASIP respectively. These memories contain the program of each ASIP, the constellation for the demapping function, the trellis configuration and the interleaving information. Depending of the configuration, only few parameters can be tune to reach another configuration. For example, we can modify the size of the frame performed on each ASIP by replacing only one instruction in the program memory.

V. Conclusion

In this paper we present our first ideas for the management of a multi-standard ASIP-based receiver for wireless communication. We focus on a multi-standards receiver developed at laboratory. Three scenarios have been defined, based on three metrics representative of application requirements and environment evolution in which the transmission is performed. These scenarios represent the three main use cases for a multi-standard receiver. The reconfiguration of an ASIP-based multi-standard wireless receiver tackles new challenges for fast and efficiency self-adaptation. Future works will deal with fast reconfiguration of a multi-ASIP platform and decision making process for smart self-adaptation.

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